Cost-effectiveness of Increasing Access to Contraception in Nigeria: A Decision Analysis

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Family planning addresses a wide range of challenges faced by developing countries. Proper contraception will prevent unintended pregnancies and reduce the rates of maternal and infant mortality. Many studies show that contraceptive methods are cost-effective in a variety of situations and countries, but a cost-effectiveness analysis has not yet been conducted in Nigeria.

While common in Nigeria, abortions are illegal unless carried out to save the woman's life. Most abortions are performed by unskilled providers, a major contribution to the country's high rate of maternal mortality and disability.[16] Contraceptive use is low across the country, with only about 14.3% of women of reproductive age using any method.[5] By increasing access to modern contraceptive methods, women can plan and manage their pregnancies, which will positively impact health outcomes for the woman and child.

METHODS

Model Structure

This paper follows the CHEERS Checklist for Health Economic Evaluations. By modelling an individual act for a given woman where at most one contraceptive method may be used, the decision tree compares three strategies to increase access to contraception. At the time of intervention, all women are sexually active, have no impairments to fertility, and are not planning to have children in the next two years. The model specifies the method of contraception and events following unintended pregnancy. Modern methods available in Nigeria include short-term resupply methods, like male condoms and oral contraceptives, and long-acting methods, like intrauterine contraceptive devices (IUDs), injections (Depo-Provera), and Norplant implants. Traditional methods include periodic abstinence and withdrawal.

In the base case, contraceptive use does not change from the status quo. Data regarding current contraceptive use and unmet need was derived from the 2018 round of Demographic and Health Surveys (DHS) in Nigeria (n=29,090).[5] As calculated by the DHS, unmet need is based on married women ages 15-49, so the compared strategies are limited to married women. Regardless of sexual activity, all currently married women are assumed to have equal risk of pregnancy.

In the first intervention scenario, all women are assumed to have access to long-acting methods of contraception. The second scenario, referred to as half coverage, models an intervention that provides modern contraception, split between short-term resupply and long-acting methods based on current usage (26.7% of modern contraceptive users use short-term methods and 73.3% use long-term methods),[5] to half of the women who currently do not use any form of contraception, while those who currently use traditional or modern methods are unaffected. The final intervention provides access to short-term resupply methods for women who currently do

not use any contraception or use traditional methods. This intervention does not impact women who are currently using short-term resupply or long-acting methods.

Method-specific pregnancy rates were calculated by a weighted average of the contraceptive methods included in the category and their usage,[5] along with the two-year failure rates under typical conditions in Nigeria.[6,7] Emergency contraception was not included in the weighted average since it is unclear which specific actions women described as "emergency contraception" during interviews. It was assumed that the chance of ectopic pregnancy, spontaneous abortion and fetal loss, and stillbirth are the same for intended and unintended pregnancies.

Table 1. Analytic Parameters and Sources

Utilities	Base Case	Distribution	Source
Ectopic Pregnancy	0.87	Uniform (0.74, 1.0)	1
Induced Abortion	0.96	Uniform (0.92, 1.0)	2
Complications from Induced Abortion	0.88	Uniform (0.76, 1.0)	2, 3
Spontaneous Abortion and Fetal Loss	0.94	Uniform (0.88, 1.0)	2
Live Birth of Unintended Pregnancy	0.74	Uniform (0.48, 1.0)	1
Stillbirth	0.92	Uniform (0.84, 1.0)	4
Transition Probabilities			
SQ No Contraception	0.533	Beta (15504.97, 13585.03)	5
SQ Traditional Methods	0.130	Beta (3781.7, 25308.3)	5
SQ Short-Term Resupply Methods	0.090	Beta (2618.1, 26471.9)	5
SQ Long-Acting Methods	0.247	Beta (7185.23, 21904.77)	5
Half Intervention No Contraception	0.267	Beta (7767.03, 21322.97)	5
Half Intervention Traditional Methods	0.130	Beta (3781.7, 25308.3)	5
Half Intervention Short-Term Resupply Methods	0.161	Beta (4683.49, 24406.51)	5
Half Intervention Long-Acting Methods	0.442	Beta (12857.78, 16232.22)	5
Provide Short-Intervention Short-Term Resupply Methods	0.753	Beta (21904.77, 7185.23)	5
Provide Short-Intervention Long-Acting Methods	0.247	Beta (7185.23, 21904.77)	5
Contraceptive Failure of Traditional Methods	0.175	Beta (7239, 34124)	5, 6
Contraceptive Failure of Short-Term Resupply Methods	0.063	Beta (2606, 38757)	5, 6
Contraceptive Failure of Long-Acting Methods	0.029	Beta (1200, 40163)	5, 6, 7
Ectopic Pregnancy	0.011	Beta (98, 8713)	8
Induced Abortion	0.559	Beta (5151566, 4064116)	9
Complications from Induced Abortion	0.398	Beta (3667841, 5547841)	9
Spontaneous Abortion and Fetal Loss	0.120	Beta (1105882, 8109800)	9
Uninterrupted Pregnancy	0.310	Beta (2856861.4, 6358820.6)	9
Stillbirth	0.085	Beta (94, 1010)	10
Costs			
Ectopic Pregnancy	1044	Gamma (118.266, 8.828)	11
Induced Abortion	312	Gamma (16, 19.5)	12
Complications from Induced Abortion	141	Gamma (16, 8.8125)	9
Spontaneous Abortion and Fetal Loss	415	Gamma (16, 25.9375)	12
Live Birth	24	Gamma (16, 1.5)	13
Stillbirth	30	Gamma (16, 1.875)	13, 14
Provide Long-Intervention	6.48	Gamma (16, 0.405)	5, 15
Half Intervention	5.74	Gamma (16, 0.35875)	5, 15
Provide Short-Intervention	3.72	Gamma (16, 0.2325)	5, 15

Utilities

Health outcomes were evaluated only for the person wanting to avoid pregnancy. Utility values for any children were not included. Effectiveness is measured through quality-adjusted life-years (QALYs) gained, where the score represents the health state valued on a scale of 0 (death) to 1 (perfect health). A utility of 1.0 was assumed for those who did not experience contraceptive failure. The decision tree covers a single life-year.

Costs

All costs were adjusted to 2018 US dollars using the consumer price index or GDP deflator. The 2018 market exchange rate was 61 Nigerian Naira per USD.[17] Costs were evaluated from the perspective of a healthcare system. For each intervention, the cost is limited to those of supplies, with the cost for short-term resupply and long-acting methods based off a weighted average.[15] The cost of a live birth does not include those associated with raising a child, and the cost of a still birth was estimated based on the value used for a live birth. When standard deviations were not available, the range was set to 25% below and above the average.

Outcomes

A willingness-to-pay (WTP) threshold of $6,099 per QALY was used to define cost-effectiveness. This value represents three times the GDP per capita in Nigeria 2018.

RESULTS

Providing long-acting contraceptive methods to all women who want to avoid pregnancy was the most cost-effective strategy at the WTP threshold with an ICER of $14.518. Probabilistic sensitivity analysis reveals that the evaluation is not sensitive to any choice of parameter.

**Table 2.** Base Case and Sensitivity Analyses of Competing Strategies

Scenario	Cost [95% uncertainty range]	Effectiveness [95% uncertainty range]	ICER
Provide long-acting methods to all who use another method	14.46 [10.78, 18.63]	0.996 [0.994, 0.999]	14.518
Provide short-acting methods (long-acting users unchanged)	18.74 [14.12, 24.32]	0.993 [0.988, 0.997]	Dominated
Provide modern methods for half who currently do not use any method	91.54 [66.65, 119.75]	0.958 [0.931, 0.984]	Dominated
Do not provide any additional contraception (status quo)	156.01 [110.03, 207.71]	0.924 [0.874, 0.971]	Dominated

CE Acceptability Curve
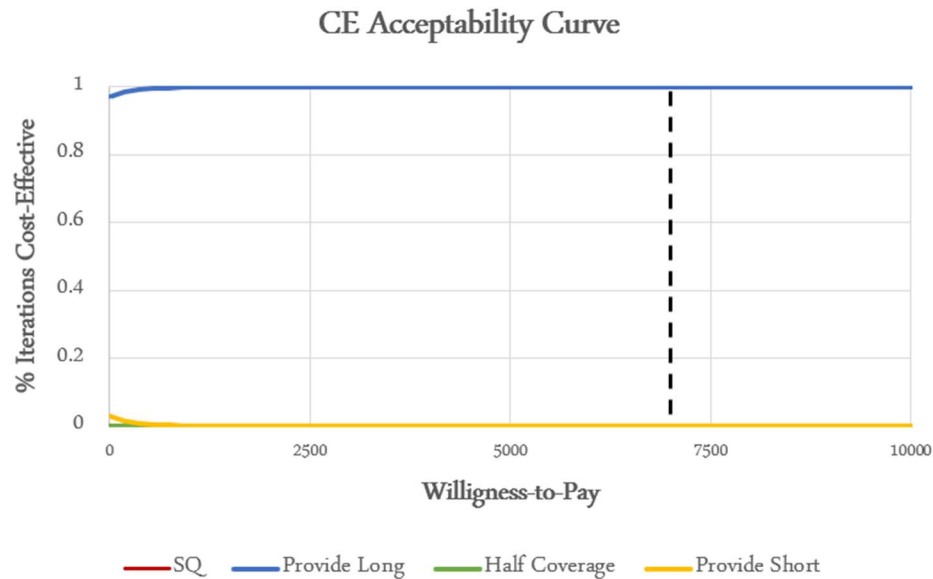
Sensitivity Analysis of Individual Variables

Univariate sensitivity analyses were performed on utilities, transition probabilities, and costs to determine the impact on the preferred strategy. Each variable was tested, and thresholds were identified for influential variables. The cost of a stillbirth was assumed from the value found for a live birth, and the cost of a live birth does not include those associated with raising a child for one year. The conclusion is not sensitive to either of these two parameters.

Providing long-acting contraception to all women remained the most cost-effective strategy above contraceptive failure rates of 3.24% for short-term resupply methods and below 5.96% for long-acting methods. At failure rates below the short-term resupply threshold or above the long-acting threshold, providing short-term resupply methods was the most cost-effective intervention. The model was not sensitive to the failure rate of traditional methods. Providing short-term resupply methods would be the most cost-effective strategy if the cost of providing long-term methods for all women who want contraception was $31.40 per person. The model was not sensitive to the cost of any other intervention. The figure above presents the results of a two-way
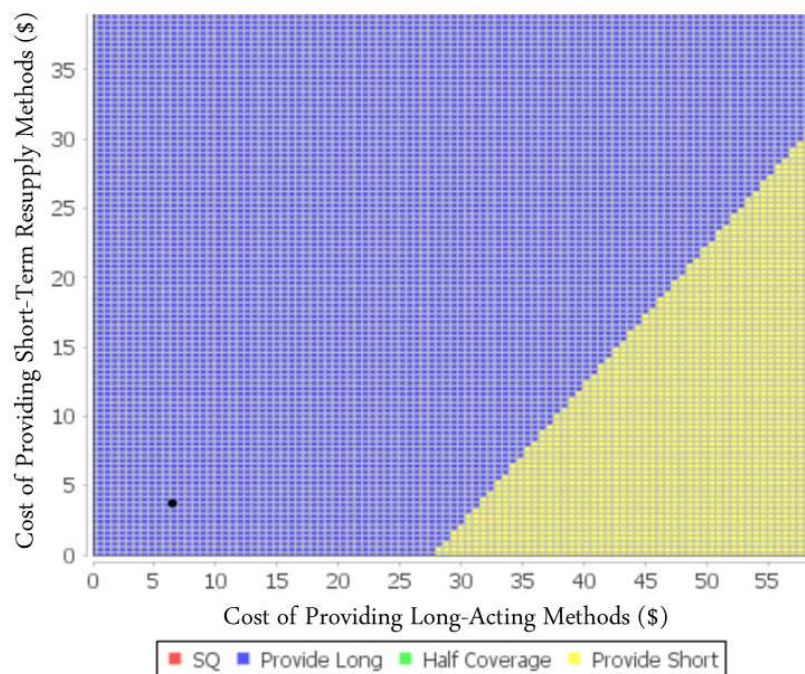
sensitivity analysis between the cost of providing long-term methods and the cost of providing short-term resupply methods. The shaded region represents the most cost-effective strategy at the given combination of costs. Given the complexity of many long-acting methods, it is possible that the additional personnel and training needed for effective use would make the provision of long-acting methods significantly more expensive per person than the provision of short-term resupply methods.

Table 3. One-Way Sensitivity Analyses on Select Variables

Variable	Base Case	Sensitivity Analysis Range	Threshold	Preferred Below Threshold	Preferred Above Threshold
Live Birth (Cost)	24	0-500	n/a	Provide Long	Provide Long
Stillbirth (Cost)	30	0-100	n/a	Provide Long	Provide Long
Contraceptive Failure of Traditional Methods (Probability)	0.175	0-1	n/a	Provide Long	Provide Long
Contraceptive Failure of Short-Term Resupply Methods (Probability)	0.063	0-1	0.0324	Provide Short	Provide Long
Contraceptive Failure of Long-Acting Methods (Probability)	0.029	0-1	0.0596	Provide Long	Provide Short
Provide Long-Intervention (Cost)	6.48	0-60	31.40	Provide Long	Provide Short

DISCUSSION

Contraceptive access can greatly impact the health of women in Nigeria and provide many social and economic benefits. Increased investment in such services to satisfy Nigeria's unmet need is essential. While the economic benefits of increased contraceptive access have been widely studied, there are only a few cost-effective analyses, and none specifically evaluate increased access in Nigeria. Although providing long-acting methods, like IUDs, injections, and implants, to all who indicate an interest in contraception is the most cost-effective strategy, the sensitivity analysis reveals that this requires a failure rate of 5.96% or better for the provided long-acting methods in order to remain the preferred strategy. Similarly, if the failure rate of short-term resupply methods, like male condoms and oral contraception, is at or below 3.24%, providing these services to all women who show interest and are not currently using long-acting methods proves to be the most cost-effective.

This decision analysis has several limitations. The tree is not iterative, so costs are limited to one life-year, which makes the calculated effects unrealistic. Furthermore, the costs of the various strategies are limited to the needed supplies and underestimate the actual costs associated with such interventions. Programming, personnel, investments for scale-ups, and other expenses need to be accounted for as well. Additionally, unmet need, by definition, is calculated "with a denominator of currently married women," from ages 15 to 45.[5] This definition limits the analysis to currently married women and may underestimate the burden of unmet need, especially since data suggests that marriage is not a necessary precursor for a significant number of women in Nigeria. Finally, the probabilities of this decision analysis are heavily based on the 2018 DHS Survey, which may not accurately reflect reality. Much of the data is based on self-reporting, which may be subject to bias, particularly for sensitive topics. Analysis shows that the strategy recommendation is sensitive to some variables, namely the cost of the interventions and

the failure rates of modern contraceptive methods in Nigeria. Collecting further data and more accurately pricing interventions would make the conclusion far more robust.

While the DHS surveys are created through self-reported information, they are known to provide nationally representative information, with high response rates and staff trained to notice potential biases.[18] This reliability strengthens the model. The standardized processes of the DHS also allow for comparison across time and with other countries. Another key strength of the decision tree is it provides a comprehensive analysis of the common paths after pregnancy and identifies nodes that need further analysis.

In conclusion, use of a decision-analytic model that compares potential strategies to increase access to contraception across Nigeria reveals that an intervention providing long-acting contraception to all women who hope to avoid pregnancy and are not currently using a long-acting method is the most cost-effective approach. As more data is collected on contraceptive failure rates in Nigeria and the cost of implementing the competing strategies, this evaluation may need to be re-examined.

REFERENCES

1. Venkatesh, K., Clark, L., & Stamilio, D. (2019). Cost-effectiveness of opportunistic salpingectomy vs tubal ligation at the time of cesarean delivery. *Obstetric Anesthesia Digest*, *39*(4), 209. doi: 10.1097/01.aoa.0000603764.51148.4e
2. Sonnenberg, F. A., Burkman, R. T., Hagerty, C., Speroff, L., & Speroff, T. (2004). Costs and net health effects of contraceptive methods. *Contraception*, *69*(6), 447–459. doi: 10.1016/j.contraception.2004.03.008
3. Lubinga, S. J., Levine, G. A., Jenny, A. M., Ngonzi, J., Mukasa-Kivunike, P., Stergachis, A., & Babigumira, J. B. (2013). Health-related quality of life and social support among women treated for abortion complications in western Uganda. *Health and Quality of Life Outcomes*, *11*(1), 118. doi: 10.1186/1477-7525-11-118
4. Danyliv, A., Gillespie, P., O'Neill, C., Tierney, M., O'Dea, A., Mcguire, B. E., … Dunne, F. P. (2015). The cost-effectiveness of screening for gestational diabetes mellitus in primary and secondary care in the Republic of Ireland. *Diabetologia*, *59*(3), 436–444. doi: 10.1007/s00125-015-3824-0
5. National Population Commission, & The DHS Program ICF. (2019, October 1). Nigeria Demographic and Health Survey, 2018. Retrieved from https://dhsprogram.com/publications/publication-fr359-dhs-final-reports.cfm.
6. Polis, C. B., Bradley, S. E., Bankole, A., Onda, T., Croft, T., & Singh, S. (2016). Contraceptive Failure Rates in the Developing World: An Analysis of Demographic and Health Survey Data in 43 Countries. *Contraception*, *94*(1), 11–17. doi: 10.1016/j.contraception.2016.03.011
7. Swende, T., & Hwande, T. (2010). Female sterilization by tubal ligation at caesarean section in Makurdi, Nigeria. *Annals of African Medicine*, *9*(4), 246. doi: 10.4103/1596-3519.70965
8. Igwegbe, A., Eleje, G., & Okpala, B. (2013). An appraisal of the management of ectopic pregnancy in a Nigerian tertiary hospital. *Annals of Medical and Health Sciences Research*, *3*(2), 166. doi: 10.4103/2141-9248.113655

9. Bankole, A., Adewole, I. F., Hussain, R., Awolude, O., Singh, S., & Akinyemi, J. O. (2015). The Incidence of Abortion in Nigeria. *International Perspectives on Sexual and Reproductive Health*, *41*(04), 170–181. doi: 10.1363/4117015

10. Suleiman, M. B., & Mokuolu, O. A. (2014). Perinatal mortality in a northwestern Nigerian vity: A wake up call. *Frontiers in Pediatrics*, *2*. doi: 10.3389/fped.2014.00105

11. J.T. Fouogue, F.Y. Fouelifack, J.H. Fouedjio, R. Tchounzou, Z. Sando, & E.T. Mboudou (2017). First steps of laparoscopic surgery in a sub-Saharan African setting: a nine-month review at the Douala Gynaeco-Obstetric and Pediatric Hospital (Cameroon). *Facts Views Vis Obgyn, 9*(02), 105-110.

12. Henshaw, S. K., Adewole, I., Singh, S., Bankole, A., Oye-Adeniran, B., & Hussain, R. (2008). Severity and cost of unsafe abortion complications treated in Nigerian hospitals. *International Family Planning Perspectives*, *34*(01), 040–051. doi: 10.1363/3404008

13. Sambo, M. N., Shamang, A., Abdulrazaq, G., & Ibrahim, A. (2013). Household cost of antenatal care and delivery services in a rural community of Kaduna state, northwestern Nigeria. *Nigerian Medical Journal*, *54*(2), 87. doi: 10.4103/0300-1652.110034

14. The neglected tragedy of stillbirths. (2016, January 20). Retrieved from https://www.who.int/reproductivehealth/topics/maternal_perinatal/stillbirth/Lancet-series/en/.

15. Population Services International, Society for Family Health, & FPWatch. (2016). Nigeria 2015 FPwatch Survey: Findings from a contraceptive commodity and service assessment among public and private sector outlets. Retrieved from https://www.psi.org/wp-content/uploads/2017/06/FPwatch-Nigeria-outlet-survey-findings-brief.pdf.

16. Guttmacher Institute. (2017, March 17). Abortion in Nigeria. Retrieved from https://www.guttmacher.org/fact-sheet/abortion-nigeria.

17. Treasury Reporting Rates of Exchange-Historical Rates. (n.d.). Retrieved from https://fiscal.treasury.gov/reports-statements/treasury-reporting-rates-exchange/historical.html.

18. Corsi, D. J., Neuman, M., Finlay, J. E., & Subramanian, S. (2012). Demographic and health surveys: a profile. *International Journal of Epidemiology*, *41*(6), 1602–1613. doi: 10.1093/ije/dys184